Progress Report of "**Validating MODIS/MISR Land Surface Reflectance and Albedo Products**" (NAG56459) (2000-2001)

Shunlin Liang
University of Maryland at College Park, MD

Charles Walthall and Craig Daughtry
USDA Agricultural Research Service at Beltsville, MD

This is the last year of this project. We have successfully implemented the work plans outlined in our original proposal. Some of our accomplishments exceed those outlined in the proposal.

PART I: Summary of the major achievements

(1). Field campaigns and ground measurements

We conducted a series of field campaigns last year, most of which were associated with airborne overflights or Terra/Landsat7 overpasses. A summary is given in the following table:

Field campaign dates	**Remotely sensed imagery**
May 11, 2000	ASIA, AVIRIS, MAS, ETM+,
August 4, 2000	ETM+
Nov. 3, 2000	ETM+
April 19, 2001	POSITIVE System
April 28, 2001	ETM+
July 22, 2001	AVIRIS, MAS, AirMISR
August 1, 2001	Low altitude AVIRIS
August 2, 2001	ETM+, ALI/Hyperion of EO1

Other imagery were collected under clear-sky conditions on the following dates without field campaigns:

IKONOS: June 3, 2000; Sept. 29, 2000; May 23, 2001;
MAS, May 24, 2000;
AVIRIS, May 24, 2000
ETM+: Oct. 4, 2000, 2000; Dec. 5, 2000, Jan. 22, 2001; Feb. 7, 2001, and Feb. 23, 2001

Besides measurements of surface reflectance spectra and albedo during the field campaigns, we also measured leaf optics and leaf area index (LAI) of different cover types. Two albedometers in a centrally-located tower collected data continuously every 10 minutes.

(2). Validating MODIS directional reflectance and albedo products

Some preliminary results on validating MODIS products (MOD09, MOD43B3 and MOD43B4) were presented in a manuscript submitted to the special issue of Remote Sensing of Environment (Liang, et al., 2001). The activities consist of atmospheric corrections, narrowband to broadband albedo conversions, image aggregation and registration, and data comparisons. Most of the algorithms were developed in prior years of the project. The preliminary results using ETM+ data indicate that all three products are reasonably accurate.

As proposed in our original proposal, we tested a new algorithm for deriving land surface broadband albedos directly from MODIS observations without employing any atmospheric correction that was originally proposed in our earlier publication (Liang, Strahler and Walthall, J. Appl. Meterol., 1999). The results were compared with MODIS albedo products. The details of the algorithm and the preliminary results were presented in a recently submitted manuscript (Liang, 2001). The approach is particularly useful when the surface conditions change dramatically (following new snow, for example) or over non-vegetated surfaces.

(3). Validating MISR directional reflectance and albedo products

Similar approaches have been used to validate the MISR products. The preliminary results are presented in a manuscript that will be submitted to the special issue of IEEE TGARS August,2001 (Fang et al., 2001).

(4). International collaborations

We have worked with a group of international scientists around the world, partly in conjunction with our NASA EO1 validation project.

Australia: We are collaborating with scientists at Australia CSIRO Land and Water on an agricultural test site at Griffith, Australia. Dr. McVicar's group has purchased 19 clear-sky ETM+ imagery for the summer growing season (Dec. 2000 to April 2001). A series of EO1 data (ALI and Hyperion) were also acquired. Dr. Liang and Ms. Monisha Kaul participated in the field campaign during early February. Most of these data are currently being processed and analyzed.

Beijing, China: We are working with Dr. Xiaowen Li at Beijing Nornal University. Dr. Li just conducted an extensive field

campaign during April – May, 2001 over an agricultural site with a series of airborne sensors and intensive ground measurements.

France: We are collaborating with Dr. Fred Baret at Institut National de la Recherche Agronomique (INRA), France. During this past growing season, they conducted extensive ground measurements over an agricultural site in Bucharest, Romania. Various forms of high-resolution imagery have been collected. Dr. Daughtry visited this group during July-August,2001.

PART III: Publication and Presentations

Below is the list of publications that are related to this project, published or submitted last year.

(1). Journal articles published

Liang, S., (2000), Numerical Experiments on Spatial Scaling of Land Surface Albedo and Leaf Area Index, *Remote Sensing Reviews*, 19:225-242.

Liang, S., (2001), Narrowband to Broadband Conversions of Land Surface Albedo, *Remote Sensing of Environment*, 76:213-238.

Liang, S., J. Stroeve, I. Grant, A. Strahler, and J. Duvel, (2000), Angular Corrections to Satellite Data for Estimating Earth's Radiation Budget, *Remote Sensing Reviews*,18:103-136.

Nolin, A. and Liang, S., (2000), Progress in Surface Particulate Medium Bidirectional Reflectance Modeling and Applications, *Remote Sensing Reviews*, 18:307-342.

Qin, W. and S. Liang, (2000), Plane-Parallel Canopy Radiation Transfer Modeling: Recent Advances and Future Directions, *Remote Sensing Reviews*, 18:281-306.

Walthall, C., J. Roujean, J. Morisette, (2000), Field and Landscape BRDF optical Wavelength Measurements: Experience, Techniques, and the Future, *Remote Sensing Reviews*, 18:533-551.

(2). Journal papers submitted

Liang, S., (2001), A direct algorithm for estimating land surface broadband albedos from MODIS Imagery, *IEEE Transactions on Geosciences and Remote Sensing*

Liang, S., H. Fang, M. Chen, (2001), Atmospheric Correction of Landsat ETM+ Land Surface Imagery: I. Methods, *IEEE Transactions on Geosciences and Remote Sensing*

Fang, H., S. Liang, M. Chen, C. Walthall, and C. Daughtry, (2001), Validating MISR land surface reflectance and albedo products, *IEEE Transactions on Geosciences and Remote Sensing*

Liang, S., H. Fang, J. Morisette, M. Chen, C. Walthall, C. Daughtry, and C. Shuey, (2001), Atmospheric Correction of Landsat ETM+ Land Surface Imagery: II. Validation and Applications, *IEEE Transactions on Geosciences and Remote Sensing*

Liang, S., H. Fang, M. Chen, C. Walthall, C. Daughtry, J. Morisette, C. Schaff, and A. Strahler, (2001), Validating MODIS land surface reflectance and albedo products: Methods and preliminary results, *Remote Sensing of Environment*

Liang, S., C. Shuey, A. Russ, H. Fang, M. Chen, C. Walthall, C. Daughtry, (2001), Narrowband to Broadband Conversions of Land Surface Albedo: II. Validation, *Remote Sensing of Environment*

(3). Conference Proceedings

Liang, S. and H. Fang, (2000), Atmospheric correction of high-resolution satellite imagery for quantitative retrieval of biophysical parameters, *Proceedings of IGARSS'2000*, Vol. VII, 2921-2923.